1 CLAIMS

2 What is claimed is:

3   1.   An apparatus for sending a heartbeat signal in cluster

4 computing system, the apparatus comprising:

5   a first host group; and

6   a first storage system associated with the first host

7 group, the first host group configured to selectively send a

8 heartbeat signal to a second host group by use of a network

9 coupled between the first host group and the second host group

10 or by use of a remote link coupled between the first storage

11 system and a second storage system associated with the second

12 host group.

13

14 2.   A method of sending a heartbeat signal in a cluster

15 computing system, the method comprising:

16   generating a heartbeat signal from a first host group;

17   selectively sending the heartbeat signal from the first

18 host group to a second host group by use of a network coupled

19 between the first host group and the second host group or by use

20 of a remote link coupled between a first storage system

21 associated with the first host group and a second storage system

22 associated with the second host group.

23

1   3.   An electronically-readable medium storing a program for

2   permitting a computer to perform method of sending a heartbeat

3   signal in a cluster computing system, the method comprising:

4   generating a heartbeat signal from a first host group;

5   selectively sending the heartbeat signal from the first

6   host group to a second host group by use of a network coupled

7   between the first host group and the second host group or by use

8   of a remote link coupled between a first storage system

9   associated with the first host group and a second storage system

10   associated with the second host group.

11

12   4.   A program code embedded on a carrier wave for causing a

13   computer to perform a method of sending a heartbeat signal in a

14   cluster computing system, the method comprising:

15   generating a heartbeat signal from a first host group;

16   selectively sending the heartbeat signal from the first

17   host group to a second host group by use of a network coupled

18   between the first host group and the second host group or by use

19   of a remote link coupled between a first storage system

20   associated with the first host group and a second storage system

21   associated with the second host group.

22

23   5.   An apparatus for receiving a heartbeat signal in cluster

24   computing system, the apparatus comprising:

1   a remote host group; and

2   a remote storage system associated with the remote host

3   group, the remote host group configured to selectively receive a

4   heartbeat signal from a network coupled with the remote host

5   group or by use of a remote link coupled to the remote storage

6   system.

7

8   6.   A method of receiving a heartbeat signal in a cluster

9   computing system, the method comprising:

10   selectively receiving a heartbeat signal in a remote host

11   group by use of a network with the remote host group or by use

12   of a remote link coupled with a storage system associated with

13   the remote host group.

14

15   7.   An electronically-readable medium storing a program for

16   permitting a computer to perform a method of receiving a

17   heartbeat signal in a cluster computing system, the method

18   comprising:

19   selectively receiving a heartbeat signal in a remote host

20   group by use of a network with the remote host group or by use

21   of a remote link coupled with a storage system associated with

22   the remote host group.

23

1   8.   A program code embedded on a carrier wave for causing a

2   computer to perform a method of receiving a heartbeat signal in

3   a cluster computing system, the method comprising:

4   selectively receiving a heartbeat signal in a remote host

5   group by use of a network with the remote host group or by use

6   of a remote link coupled with a storage system associated with

7   the remote host group.

8

9   9.   A cluster computing system, comprising:

10   a production host group;

11   a standby host group coupled to the production host group

12 by a network; and

13   a remote mirror coupled between the production host group

14 and the standby host group;

15   the production host group configured to selectively send a

16 heartbeat signal to the standby host group by use of at least

17 one of the network and the remote mirror.

18

19 10. A method of checking for failure in a cluster computing

20 system, the method comprising:

21   generating a heartbeat signal from a first host group;

22   selectively sending the heartbeat signal from the first

23 host group to a second to host group by use of a network coupled

1   between the host groups or a remote mirror coupled between the

2   host groups.

3

4   11. A cluster computing system, comprising:

5   a production host group;

6   a standby host group coupled to the production host group

7   by a network; and

8   a remote mirror coupled between the production host group

9   and the standby host group, the remote mirror including a

10   production site heartbeat storage volume (heartbeat PVOL) and a

11   standby site heartbeat storage volume (heartbeat SVOL) coupled

12   by a remote link to the heartbeat PVOL;

13   the production host group configured to selectively send a

14   heartbeat signal to the standby host group by use of at least

15   one of the network and the remote link.

16

17   12. The cluster computing system of claim 11 wherein the

18   production host group comprises a first heartbeat check module

19   configured to generate the heartbeat signal.

20

21   13. The cluster computing system of claim 11 wherein the

22   standby host group comprises a second heartbeat check module

23   configured to receive the heartbeat signal.

24

1   14. The cluster computing system of claim 11 wherein the

2   standby host group manages operations of the cluster computing

3   system if an invalid heartbeat signal is received by the standby

4   host group from the production host group.

5

6   15. The cluster computing system of claim 11 wherein the

7   heartbeat message comprises: a serial number assigned to the

8   heartbeat message, a time indicator indicating a time of the

9   generation of the heartbeat message, and an identifier

10 identifying a sender of the heartbeat message.

11

12 16. The cluster computing system of claim 11 further

13 comprising:

14   a second remote mirror coupled between the production host

15 group and the standby host group, the second remote mirror

16 including a second remote link for transmitting a heartbeat

17 signal;

18   the standby host group configured to selectively send a

19 heartbeat signal to the production host group by use of at least

20 one of the network and the second remote link.

21

22 17. A method of checking for failure in a cluster computing

23 system, the method comprising:

24   generating a heartbeat signal from a production host group;

1   selectively sending the heartbeat signal to the standby

2   host group from the production host group by use of at least one

3   of a network and a remote link; and

4   enabling the standby host group to manage operations of the

5   cluster computing system if an invalid heartbeat signal is

6   received by the standby host group from the production host

7   group.

8

9   18.   The method of claim 17 further comprising:

10   selectively sending a heartbeat signal to the production

11   host group from the standby host group by use of at least one of

12   a network and a second remote link.

13

14   19.   The method of claim 17 further comprising:

15   installing remote mirrors in the cluster computing system,

16   including:

17   registering a first storage volume to a device address

18   entry, the first storage volume located in a production site,

19   and, from the production site, changing a remote mirror that

20   includes the first storage volume into an enabled mode;

21   sending an activation message from the production site to a

22   standby site;

1   registering a second storage volume to the device address

2   entry, the second storage volume located in the standby site;

3   and

4   from the standby site, changing the remote mirror into an

5   enabled mode to install a remote mirror formed by the first

6   storage volume and second storage volume.

7

8   20.   The method of claim 17 further comprising:

9   de-installing remote mirrors in the cluster computing

10   system, including:

11   from a production site, changing a remote mirror into a

12   disabled mode;

13   sending a de-activation message from the first production

14   site to a standby site; and

15   from the standby site, changing the remote mirror into a

16   disabled mode to de-install the remote mirror.

17

18   21.   The method of claim 17 wherein the selectively sending step

19   comprises:

20   determining if a network between the production site host

21   and the standby site host is enabled;

22   if the network is enabled, sending a heartbeat message along

23   the network from the production site host to the standby site

24   host;

1   determining if a remote mirror between the production site

2 host and the standby site host is enabled; and

3   if the remote mirror is enabled, sending a heartbeat message

4 along the remote mirror from the production site host to the

5 standby site host.

6

7 22.   The method of claim 17 further comprising:

8   receiving a heartbeat message from the production site host

9 to the standby site host in the cluster computing system,

10 including:

11   determining if a network between the production site host

12 and the standby site host is enabled;

13   if the network is enabled, checking for a heartbeat message

14 along the network from the production site host to the standby

15 site host;

16   determining if a remote mirror between the production site

17 host and the standby site host is enabled;

18   if the remote mirror is enabled, checking for a heartbeat

19 message along the remote mirror from the production site host to

20 the standby site host; and

21   if an invalid heartbeat is received along the network and

22 along the remote mirror, enabling the standby host to manage

23 operations of the cluster computing system.

24

1 23. A method of setting a heartbeat checking procedure between

2 a primary group and a secondary group in a cluster computing

3 system, the method comprising:

4   providing a request command that determines the heartbeat

5 checking procedure;

6   responsive to the request command, enabling a first

7 heartbeat check module in the primary group to activate or de-

8 activate a network between the primary group and the secondary

9 group;

10   responsive to the request command, enabling the first

11 heartbeat check module to activate or de-activate a remote

12 mirror between the primary group and the secondary group;

13   permitting the first heartbeat check module to send the

14 request command to a second heartbeat check module in the

15 secondary group;

16   responsive to the request command, enabling the second

17 heartbeat check module to activate or de-activate the network

18 between the primary group and the secondary group;

19   responsive to the request command, enabling the second

20 heartbeat check module to activate or de-activate the remote

21 mirror between the primary group and the secondary group;

22   if the second heartbeat check module has activated the

23 network, then checking for a heartbeat signal along the network;

24 and

1   if the second heartbeat check module has activated the

2   remote mirror, then checking for a heartbeat signal along the

3   remote mirror.

4

5   24. A method of failure notification in a cluster computing

6   system, the method comprising:

7   selectively activating a network between a primary group

8   and a secondary group;

9   selectively activating a remote mirror between the primary

10   group and the secondary group;

11   checking for a failure occurrence in the primary group;

12   if the network is activated, then sending a failure

13   notification message from the primary group to the secondary

14   group along the network;

15   if the remote mirror is activated, then sending a failure

16   notification message from the primary group to the secondary

17   group along the remote mirror; and

18   based upon the failure notification message, displaying in

19   the secondary group an indication of the failure occurrence.

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